Location Detection:

Technical Alternatives and Deployment Perspectives

Dr. Martin Kuipers

SIEMENS

Contents

1. Current Situation of Location Based Services

2. Positioning Techniques in 3GPP

3. Technical Alternatives and Deployment Perspectives

4. Legal Aspects

5. Summary

Current Situation of Location Based Services

Introduction - Current Market Situation

- Location Based Services (LBS) do not play the role expected two years ago

- The only driver for implementing positioning technologies in the networks is the FCC rule in the U.S.

- Commercial LBS still wait for success, although many applications were proposed

- Operators state, that the current situation is also a technology issue

How Location Based Services look like today

- Typical Location Based Services offered by operators

  - Find nearest points of interests (e.g. cash machines, gas stations, pharmacy, friends)

  - Local area information (e.g. weather, traffic jams, events)

  - Navigation service (e.g. route information, current location)

- Usage via WAP or SMS

- Results are presented mostly as text lists

- Positioning results are often based on Cell Identification with poor accuracy

SIEMENS

Positioning Techniques in 3GPP

Positioning Techniques in 3GPP

**Standard LCS Methods in GERAN**

TS 43.059 GERAN LCS Stage 2:

- Cell coverage based positioning method

- Enhanced Observed Time Difference (E-OTD) positioning method

- GPS based positioning methods

- Uplink Time Difference of Arrival (U-TDOA) positioning method

Standard LCS Methods in UTRAN

TS 25.305 UTRAN Stage 2:

- Cell coverage based positioning method

- OTDOA positioning method

- GPS based positioning methods

- (Uplink Time Difference of Arrival (U-TDOA) positioning method)
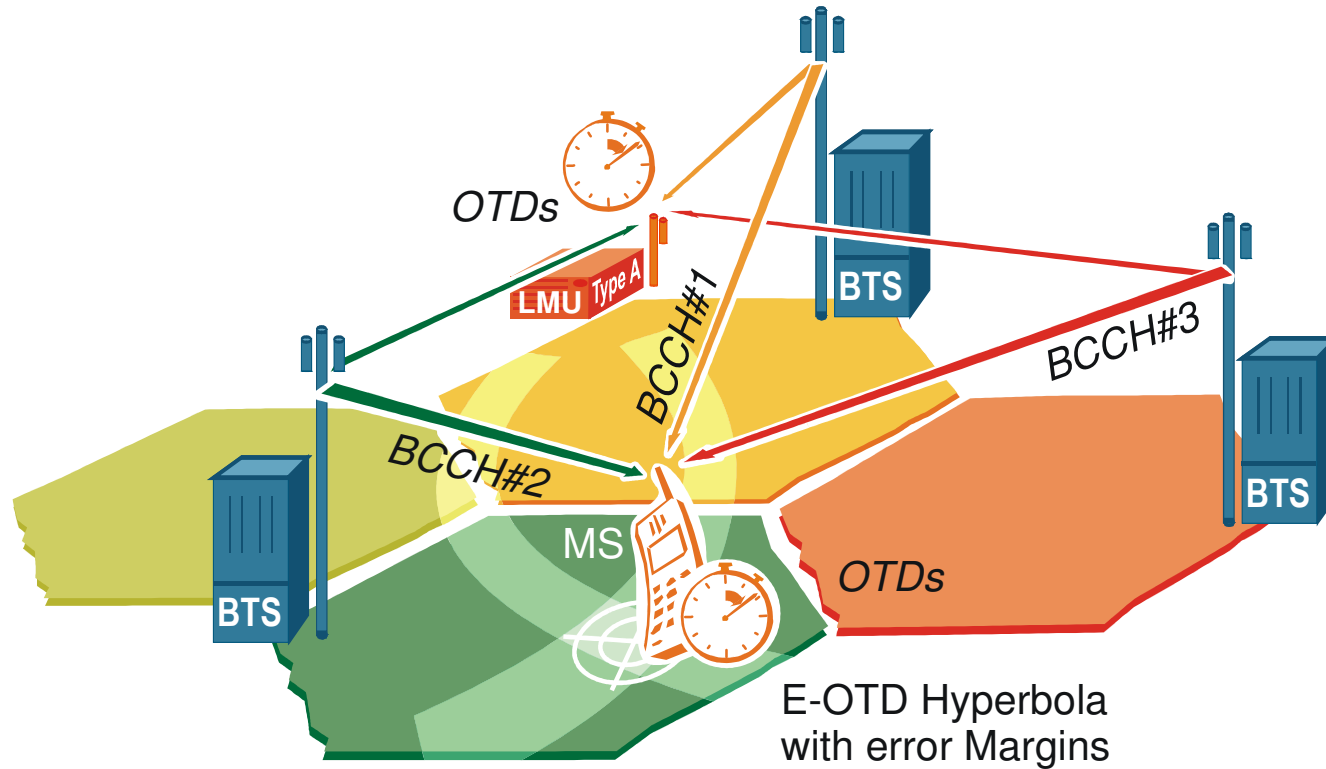
Cell ID – Timing Advance

Cell#1

Cell#3

BTS

Serving Cell#2

TA3

MS
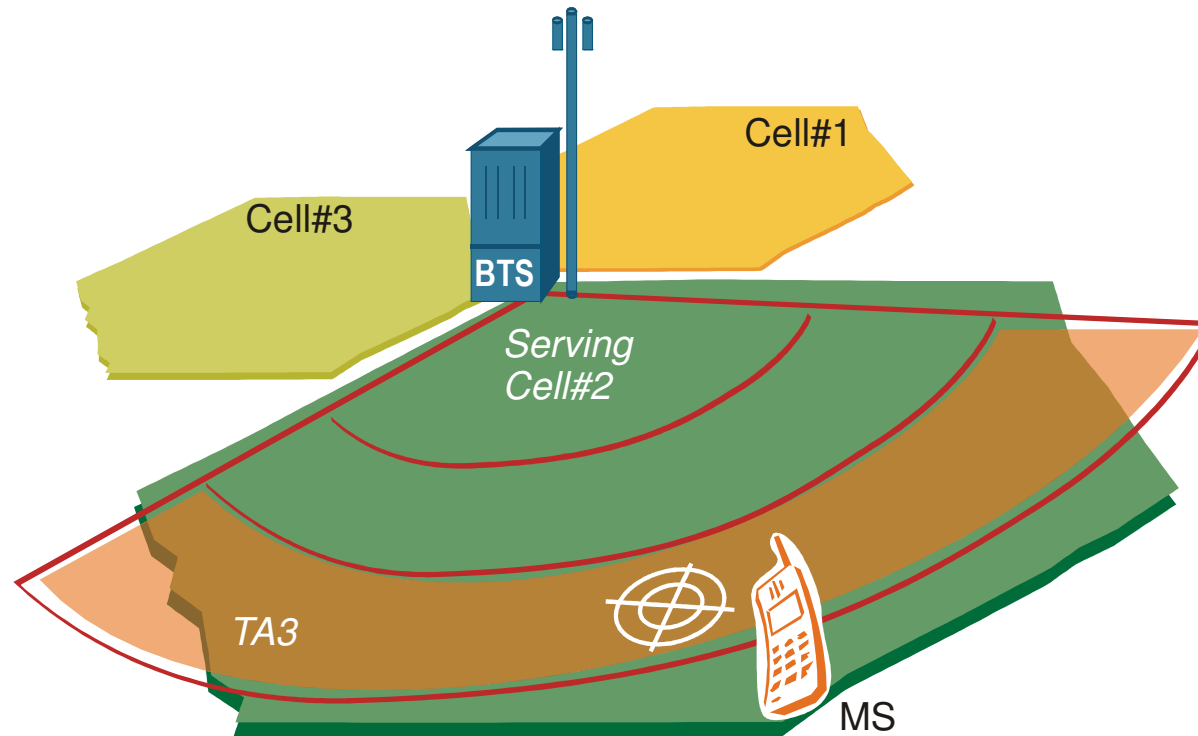
Principle

- Timing Advance is a GSM specific parameter

- It is a measure of the BTS ↔ MS round trip time and used to ensure that the bursts from the MS arrive at the BTS at the correct time
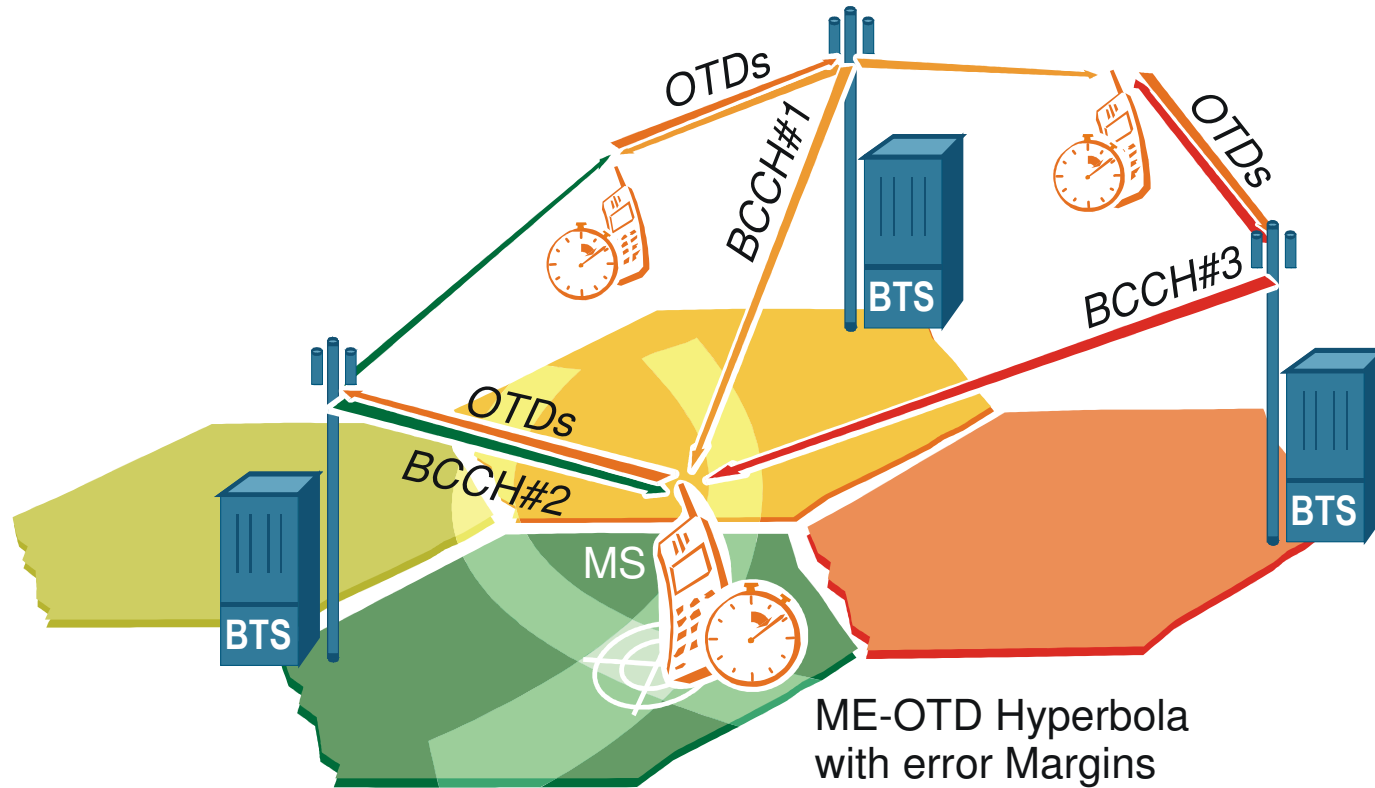
SIEMENS

Enhanced Observed Time Difference

OTDs

LMU Type A

BCCH#1

BTS

BCCH#3

BCCH#2

BTS

MS

OTDs

BTS

BTS

E-OTD Hyperbola
with error Margins

Principle:

- E-OTD is based on the determination of the timing difference between received signals

Matrix E-OTD

ME-OTD Hyperbola
with error Margins
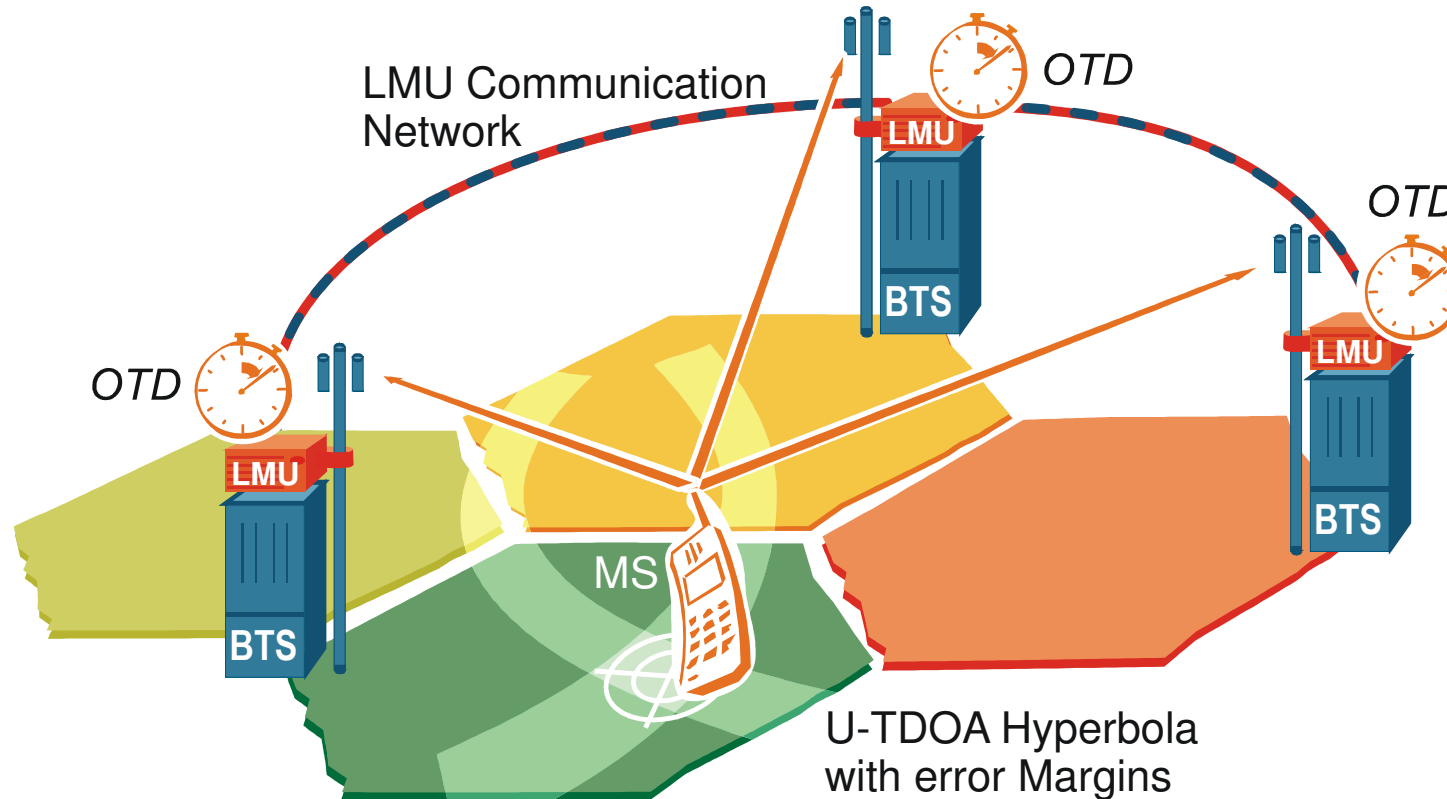
Principle:

- ME-OTD is E-OTD without LMUs

- Handset measurements substitute the LMU measurements

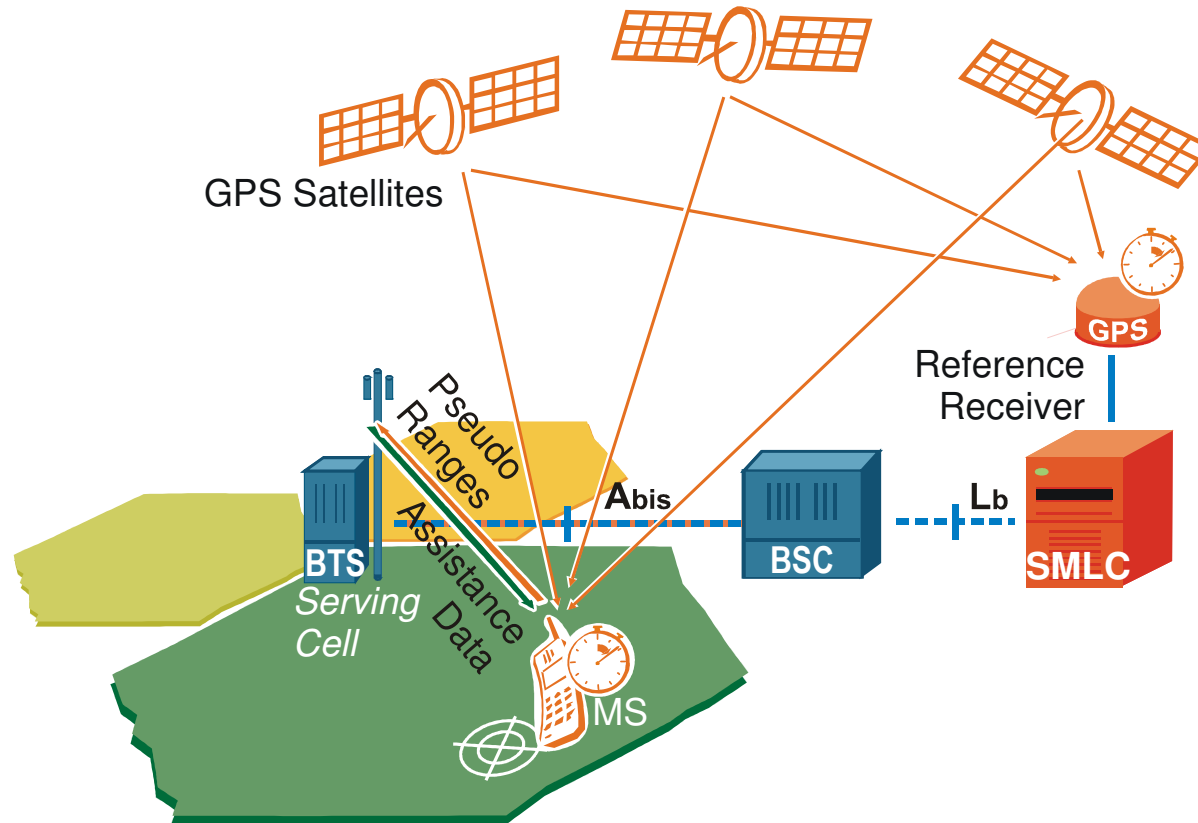- More than one handset is positioned simultaneously

Uplink Time Difference of Arrival

Principle:

- U-TDOA based on the determination of the timing difference between signals received from the MS in uplink direction at LMUs

Assisted- GPS

GPS Satellites

GPS

Reference
Receiver

Pseudo
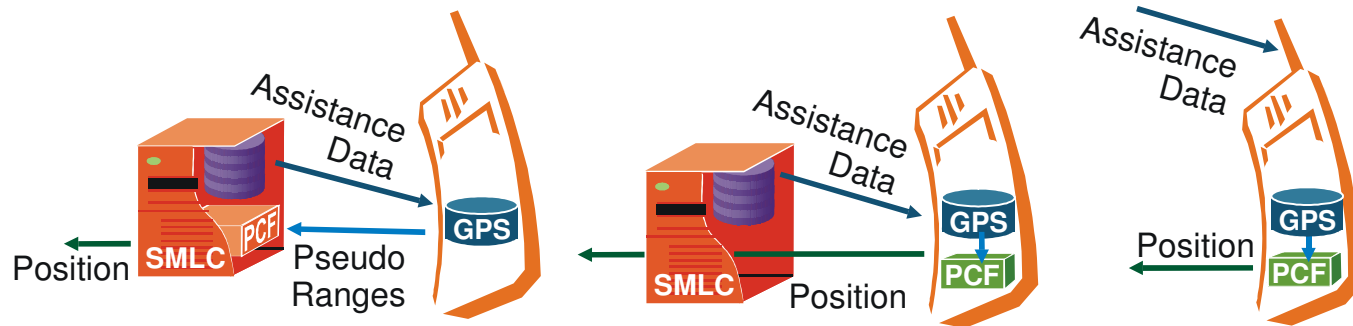Ranges

Assistance
Data

BTS
*Serving
Cell*

A_{bis}

BSC

L_b

SMLC

MS

Principle

- Improvement of conventional GPS (better coverage, faster)

- MS measures time of arrival of satellite signals

- Satellite information and acquisition assistance are provided by the RAN

SIEMENS

Martin Kuipers, Location Detection   2005/11/4

12

A-GPS Modes

|	MS-Assisted	MS-Based	Standalone
Baseband Processing	(mobile)	(mobile)	(mobile)
Pseudorange Calculation	(mobile)	(mobile)	(mobile)
Position Calculation	(tower)	(mobile)	(mobile)
Decoding of Satellite Data	(tower)	(tower)	(mobile)
Selection of Satellites	(tower)	(tower)	(mobile)

Technical Alternatives and Deployment Perspectives

Alternative Positioning Techniques

There are a number of alternative approaches ….

- RF fingerprinting
  - *"Time variant reference data"*

- Terrestrial base network solutions
  - *"Additional receiver and reference data"*

- Angle of arrival
  - *"Additional antenna hardware and signal processing"*

- Beacons or RF-ID tags
  - *"Deployment and O&M"*

- Reception power levels
  - *"Reference data and accuracy"*

… but non of them is plug & play or easily deployed

SIEMENS

CIT+ Overview
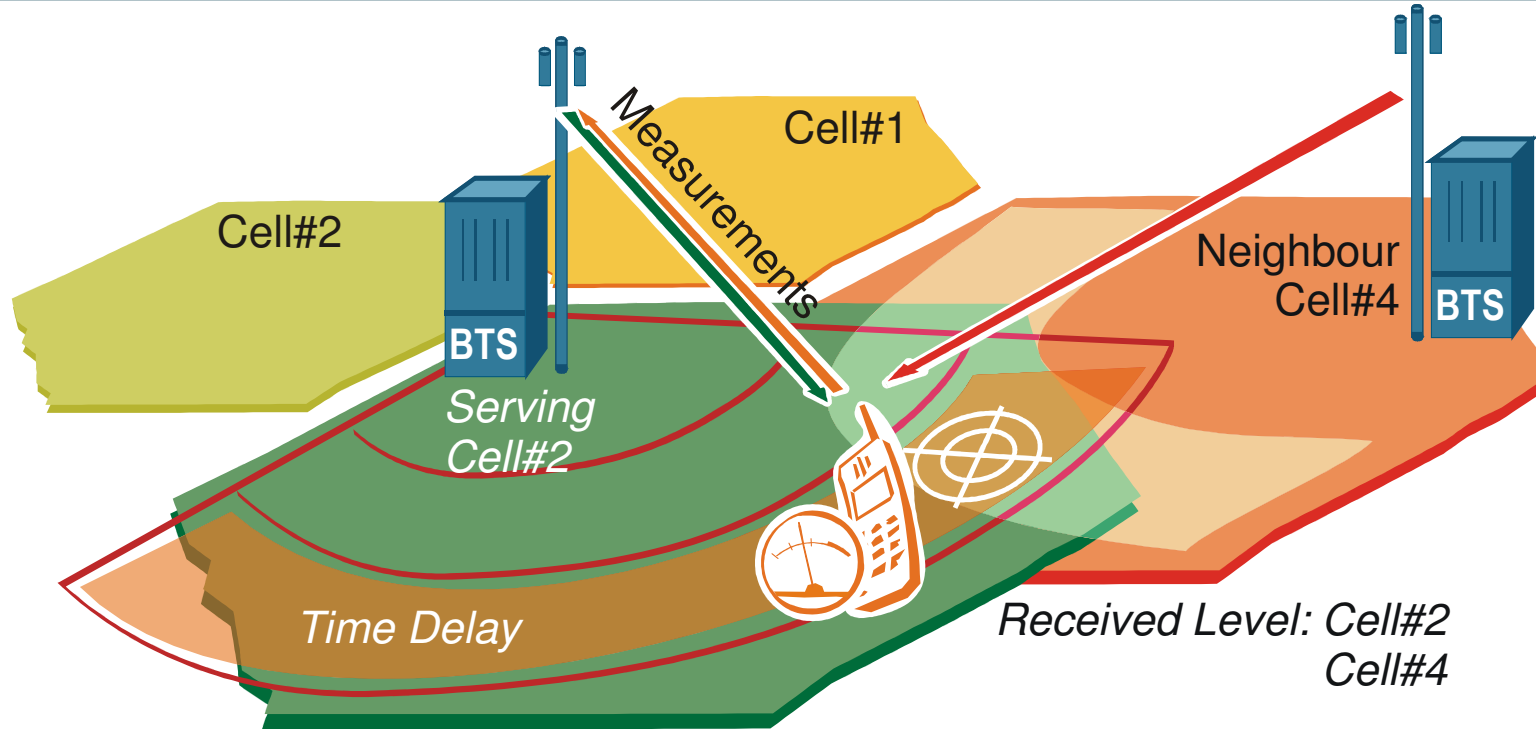
- Use of measurements that are already available:

  - Cell identification

  - Propagation delay or round trip time measurement

  - Reception power or pathloss measurement

Principle of CIT+ Positioning

- Measurements are available in many cellular networks including 2G (GSM) and 3G (UTRAN) networks with legacy handsets

- Comparison of measured pathlosses with values from a propagation model

- Simple models like Okamura-Hata are sufficient. No field strength predictions or recordings required.

- Operator needs only to provide network configuration data
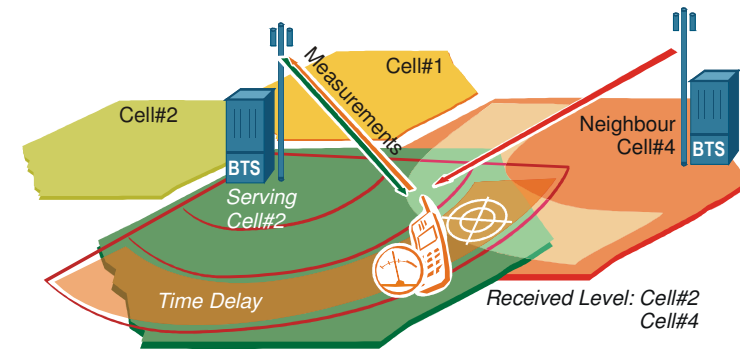
Outline of the algorithm

1. Determination of the serving cell(s)

2. Restriction of the area of interest to the zone corresponding to the reported TA/RTT values

3. Assessment of distances to base stations from timing advance and comparison between measured pathloss and pathloss models

4. Estimation of user position by optimization of a log-likelihood function ("Cost function")

Use case – Find a cash machine

46 cash machines in your vicinity

1. Deutsche Bank
distance approx. 1 km
Siemensdamm 43-49
13629 Berlin

2. Sparkasse
distance approx. 1 km
Popitzweg 18
13629 Berlin

3. ING-DiBa
distance approx. 1 km
Zossener Straße 10
14974 Ludwigsfelde

Enabling by CIT+

- **Provided accuracy enables direct indication on maps**

- **User expectations are fulfilled**

- **Investment costs are very low while addressing all subscribers**

Secure User Plane Location
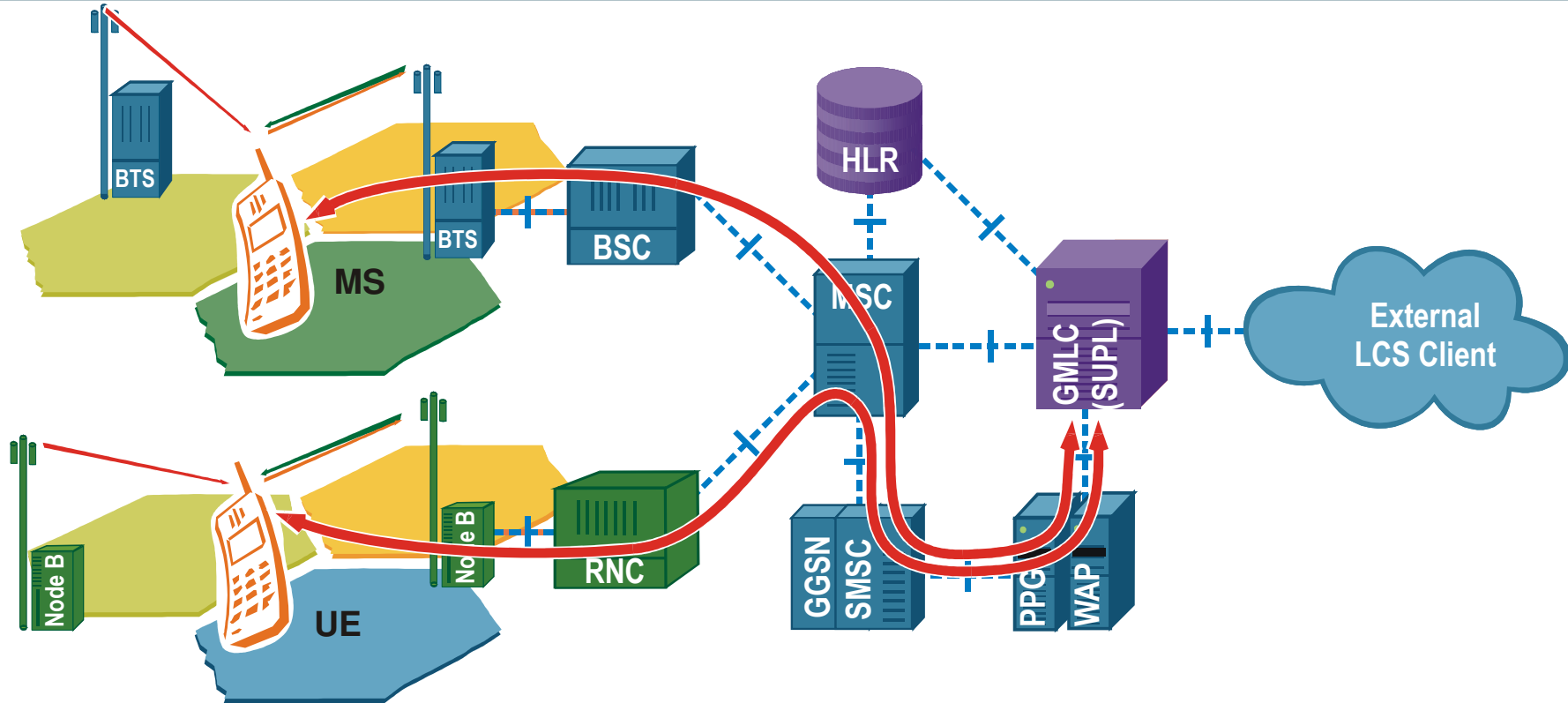
Principle:

- Control plane architecture (SMLC & GMLC) is replaced by user plane communication

- Different methods are used for session Initiation (e.g. WAP Push, SMS)

- Communication via wrapped standard messages

SIEMENS

Deployment Perspectives I

CI+TA

- CI is already available in most wireless networks

- Small improvement of CI+TA does not justify investment and architectural changes

E-OTD

- US operators started to deploy E-OTD to fulfill E911 requirements but didn't succeed

- Investment in infrastructure (LMU & SMLC) is rather high and not done for commercial services

ME-OTD

- Privacy and technical issues make a deployment unlikely

Deployment Perspectives II

U-TDOA

- US operators are deploying U-TDOA to fulfill E911 requirements since it is network based ($\rightarrow$lower requirements)

- Investment in infrastructure (LMU & SMLC) is rather high and not done for commercial services

A-GPS

- A-GPS will most likely be deployed in the near future

- First choice for outdoor application

- A-GPS via SUPL is a likely scenario

CIT+

- Can provide a lot of services to mass market with legacy handsets

- Well suited as an A-GPS fallback

- SUPL solutions possible

SIEMENS

Legal Aspects

Andreas Teuscher, Computacenter

Anforderungen an Betreiber I

Telekommunikationsgesetz, § *85 Fernmeldegeheimnis*
(1) Dem Fernmeldegeheimnis unterliegen der Inhalt der Telekommunikation und ihre näheren Umstände, insbesondere die Tatsache, ob jemand an einem Telekommunikationsvorgang beteiligt ist oder war. Das Fernmeldegeheimnis erstreckt sich auch auf die näheren Umstände erfolgloser Verbindungsversuche.

(2) Zur Wahrung des Fernmeldegeheimnisses ist verpflichtet, wer geschäftsmäßig Telekommunikationsdienste erbringt oder daran mitwirkt.

Telekommunikations-Kundenschutzverordnung, § *6 Leistungseinstellungen*
Grundlegende Anforderungen, die eine Beschränkung von Universaldienstleistungen rechtfertigen, sind
1.   die Sicherheit des Netzbetriebes,
2.   die Aufrechterhaltung der Netzintegrität, insbesondere die Vermeidung schwerwiegender Störungen des Netzes, der Software oder gespeicherter Daten,
3.   die Interoperabilität der Dienste,
4.   der Datenschutz.

Anforderungen an Betreiber II

Teledienste Datenschutzgesetz § 1 Geltungsbereich

Die nachfolgenden Vorschriften gelten für den Schutz personenbezogener Daten der Nutzer von Telediensten im Sinne des Teledienstegesetzes bei der Erhebung, Verarbeitung und Nutzung dieser Daten durch Diensteanbieter. Sie gelten nicht bei der Erhebung, Verarbeitung und Nutzung personenbezogener Daten im

- *Dienst- und Arbeitsverhältnis, soweit die Nutzung der Teledienste zu ausschließlich beruflichen oder dienstlichen Zwecken erfolgt,*
- *innerhalb von oder zwischen Unternehmen oder öffentlichen Stellen, soweit die Nutzung der Teledienste zur ausschließlichen Steuerung von Arbeits- oder Geschäftsprozessen erfolgt.*

Bundesdatenschutzgesetz § 1 Zweck und Anwendungsbereich des Gesetzes

(1) *Zweck dieses Gesetzes ist es, den einzelnen davor zu schützen, dass er durch den Umgang mit seinen personenbezogenen Daten in seinem Persönlichkeitsrecht nicht beeinträchtigt wird.*

(2) *Dieses Gesetz gilt für die Erhebung, Verarbeitung & Nutzung personenbezogener Daten durch*

DIRECTIVE 2002/58/EC of July 2002

Concerning the processing of personal data and the protection of privacy in the electronic communications sector (Directive on privacy and electronic communications)

Location data *may refer to the latitude, longitude and altitude of the user's terminal equipment, to the direction of travel, to the level of accuracy of the location information, to the identification of the network cell in which the terminal equipment is located at a certain point in time and to the time the location information was recorded.*

Article 9
Location data other than traffic data
1. … such data may only be processed when they are made anonymous, or with the consent of the users or subscribers to the extent and for the duration necessary for the provision of a value added service. …

Summary

Summary

- Location based services require more accurate positioning techniques

- Exotic positioning alternatives are not suitable to solve the LBS problem

- A-GPS will most probably be the positioning technology introduced into the networks in near future

- CIT+ can serve the mass market with legacy phones

- Tendency to use user plane communication instead of control plane architecture

- Positioning information is considered as personal data and protected by national and international regulations